EXPLORATORY ANALYSIS OF A RESEARCH AND DEVELOPMENT GAME

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As part of an undergraduate psychology course on Human Problems in Industry, a research and development (R&D) game has been developed for student laboratory participation.[1] This paper reports on the first use of this game, exploring its potential for small group research. In addition, the report will examine the effects of two innovations, specifically an "open-world," created by closed-circuit television, and the use of "contextual maps" as team "memories."

Game Description

The R&D game was played by five three-man teams (Athens Bangor, Casper, Rutland and Syracuse), which competed to earn the most money by winning contracts. In each of 12 three-hour periods, the teams bid on contracts awarded for "products" consisting of pairs of words. The problem for a team interested in bidding on a contract was to convert the first word into the second of the pair, according to a set of rules specifying the costs of the conversion processes. (See Players' Manual in Appendix.) There were numerous ways for solving any word-pair,

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[1] The game was designed by Frederick Kling and developed under the auspices of J. L. Kennedy of the Princeton University Department of Psychology, as part of the Project SOBIG research program.

and the team devising the cheapest solution was in the most advantageous position for bidding on the contract. A team would arrive at a bid by adding to its "production cost" the profit per unit that it hoped to make.

Winning a contract would schedule a team's hypothetical factory for a three-month period (compressed game time). There were limits as to how far in advance a team could schedule its factory. As there were not enough contracts to keep all factories busy during a game "year" (one three-hour period), a limited number of "fixed fee" contracts were available, the obtaining of which would provide a team with a moderate profit for a four-month period. These were awarded on a first come - first served basis to requesting teams.

All teams were provided with telephones, by means of which they could submit their bids or request information as to other teams' production costs. There was a charge for every phone call made, which when added to a fixed yearly overhead cost, reduced a team's net yearly profit.

Starting the game with no capital, the teams' profits and losses accumulated over each year until the game was completed. Two separate games were played by the participants, for after six periods the winners of the first game were declared and all teams started over with a zero account to play for another six periods.

Programmed Teams

Five programmed teams (Georgia, Maine, Wyoming, Vermont, New York), operated by the experimenter, competed with the human teams for contracts. The bidding strategies of the programmed teams related the amount of profit sought to their extant factory schedules. The programs of the teams varied in the amount of profit sought.

In a given period of play, each programmed team was assigned the contract production costs of a specific human team. These assignments were changed each period so that all programmed teams had the average production ability of the human teams.

The "Open World"

A closed circuit television camera and receiver in each game room provided audio-visual access of any team to any other. When one team wished to observe another, it made a request through the central switchboard, where the television was controlled. The standard charge of $1000 was made for such phone calls.

A team generally would not know if and by whom it was being observed. Should two teams be tuned to each other however, they could communicate reciprocally.

"Contextual Maps"

At the experimenter's request, each team maintained a

"contextual map" (Kennedy and Putt, 1956-57), in which were recorded their observations of other teams after every game session. The accumulated information provided the team with its own graphic "memory" for ready reference when needed. For research purposes, the method was assessed as a data-gathering device; it reduces data-overload because all information is pre-filtered for relevance by the participants themselves.

Essentially, the contextual map is a method for displaying complex information on a large wall chart. For the R&D game, it consisted of a matrix (Fig. 1) placed on the wall of each game room. Every important entity in the environment was represented on the abcissa and successive periods of operation (game years) were arranged sequentially on the ordinate. Each entry was made on a 5" × 8" card on which the team could store any information about itself and the other teams that it desired. The suggestion was made by the experimenter that three kinds of information would turn out to be important, namely (1) Team Organization, (2) Team Strategy, and (3) Future Plans or Predictions, but some teams did not follow this suggestion. The map was constructed during a two-hour team meeting ("debriefing") after each 3-hour period of operations, during which the team members discussed the events and reached consensus on the information that should be posted on the map.

Team Composition

As a control on the personalities of the participants, the teams were homogeneously composed according to system types as developed in they theory of Harvey, Hunt and Schroder (1961). Previous studies (Davis, 1962; Driver, 1962; Tuckman, 1963) have shown this theory to be of predictive value for group behavior. In accord with the theory (described more extensively in the above sources), the participants were classified according to their closest fit to one of four nodes along a cognitive concrete-to-abstract continuum. These classifications were made on the basis of personality tests administered prior to beginning the game.[2] The team compositions were as shown in Table 1.

Because the participants comprised all the members of an undergraduate psychology course, it was not possible to always select "pure" cases of the different personality types. Hence the team compositions were arranged more in terms of dominating tendencies.

Results

While competitive in spirit, the teams' performances were not very competitive in the sense that the lead position remained in doubt through the games. While indeed there were period-by-period fluctuations in the earnings of the different teams, in

[2]The pre-tests included the Situation Interpretation Test, the Sentence Completion Test, the Machiavellian Scale, the F-Scale, the Rigidity Scale, the Dogmatism Scale, and the Guilford-Zimmerman Ascendance-Submission Scale. The use of the scales for determining personality systems is described in Schroder and Streufert (1962).

both games the relative positions of the human teams on accumulated earnings changed little after the first period. In the first game, for example, the Bangor team made so much money in the first period that its cumulative earnings remained the highest throughout the rest of the game. The pattern was repeated in the second game, with Casper having the greatest accumulated earnings of the human teams for all but one period. Table 2 shows the weekly standings of the teams according to weekly and accumulated earnings.

The programmed teams proved to be poor competition. While they could and would outperform the human teams in specific periods, by the ends of both games all human teams had netted more profit than the programmed teams.

Reflecting perhaps an effort by the players to overcome the inflexibility of the economic positions mentioned above, coalitions were formed in each of the games. The first was relatively simple, an exchange of information on word-pair solutions between Casper and Syracuse. When Casper failed to benefit thereby, it abandoned the partnership.

A more full-fledged alliance developed between Bangor and Rutland in the second game. The two teams became essentially a single unit, sharing labor on word pair solutions and decision-making, and eventually pooling their combined profits.

Ethics

An unexpected but interesting development was the concern with ethics among the players. Prior to beginning the game, the players were so worried lest other teams steal their secrets that a majority vote succeeded in getting the game director to install separate locks on all doors. In this atmosphere of distrust, several incidents aroused the indignation of the players. On one occasion there was pilfering of word-pair solutions, on another illicit locomotion through game rooms. Perhaps the crowning achievement was one player's middle-of-the-night break into the laboratory for the purpose of obtaining game information! As punishment for the offenders, the majority of players (unsuccessfully) demanded an economic penalty to be enforced by the game director.

Use of Television

The teams made considerable use of the television facilities to observe the organization and methods of other teams. As Fig. 2 shows however, the observation activity, as indexed by the total number of requests to watch other teams, reached a peak in the third period of the first game, after which it showed a general decline. This means that at first the teams tended to watch several other teams, but toward the end they would more likely tune in on only one or two teams per game session. Whether this latter phenomenon indicates a lack of interest in watching

the TV or an interest in only a few teams cannot be established, but likely both factors were operating.

Observation revealed that the teams attempted, rather successfully, to defeat the "open world" system. They employed many devices to maintain secrecy, including coded communications, note writing, making noises into the microphone, and working under their tables. One team (Syracuse) rather ingeniously used noise making to discover who was observing them, for if they obtained feedback of their own noises through their TV monitor, they would know that the team they were watching was also watching them.

Performance Factors

An attempt was made to discover the main factors leading to success in playing the game. Essentially, the determinants of good performance seemed to be (a) R&D ability, i.e., a general capability of producing low-cost word-pair solutions, and (b) taking advantage of the fixed fee contracts available.

To index R&D ability, the cost reduction (per cent) of each word-pair solution over the given cost was averaged for each team for each period of play. The weekly ranks of the human teams were determined on this basis, revealing no consistent differences among the teams (Fig. 3). The correlation between rank on word-pair ability and rank on earnings was then computed for each session (Fig. 4). This correlation was significant in only two

period (the second). However, examination of the data revealed that in nine of the 12 sessions, the best performing team was first or tied for first in overall word pair ability (see Fig. 4). Thus, indications are that being best in word-pair ability in any period was a main factor for success, but being less than best did not determine a team's relative performance. Apparently, other factors then entered in. The one other determinant that was established was the use of fixed-fee contracts, which provided an alternative to a team when it could not obtain a competitive contract. This was shown by the finding that the average number of fixed-fee contracts obtained by the best performing team in any session was .92, the 2, 3, and 4 rank teams obtained .78, and the lowest team (rank 5) averaged only .55 fixed fee contracts per session. In other words, top performance was associated not only with word-pair ability but also with obtaining about one fixed-fee contract per session. (This might be obtained not only in emergencies, but also as a strategic measure at the beginning of the game where a team could utilize the time gained to work on its word-pair solutions.)

Several other variables of team behavior were examined for possible correlation with performance per session. No significant relations were found with respect to such factors as: number of phone calls on other team's production costs, number of contracts won, size (in number of units) of contracts won, and word-pair

exploitation (obtaining several contracts from one word pair).

Inter-Team Differences

Inter-team differences appeared on several variables which strongly suggest the effects of the team composition. The variables all pertain directly or indirectly to information processing.

Information seeking. In addition to the information routinely provided, teams could, for the fee of a telephone call, learn other teams' production costs and observe other teams on the television. Information on production costs could be obtained in one of two forms, namely, (a) the lowest production cost submitted, or (b) the production cost of a particular team. The extent to which different teams sought this information is shown in Fig. 5. Most phone calls on production costs were made by the Casper and Syracuse teams, which were composed of the most cognitively-concrete and most cognitively-abstract individuals respectively. Lowest in production-cost information seeking was the Athens team, composed of "system two" individuals in the Harvey, Hunt, and Schroder model. Not only did this group seek relatively little information, but that which it did obtain was quite simple. As Fig. 5 shows, Athens secured proportionally more information on the lowest production costs submitted, which provides no cues on particular other teams, and was used but little by most teams.

Thus Athens restricted both its quantity and quality of incoming information on production costs.

Figure 6 shows the number of information seeking phone calls for the first and second games. While three teams remained relatively constant in their number of calls, Syracuse, the most abstract team, significantly increased its number of calls over time. In contrast, the Athens team made fewer calls in the second game.

As Fig. 7 shows, all teams made much use of the television in the first game, but Athens was again lowest on this form of information gathering. This team curtailed its usage to a drastically low level in the second game, virtually cutting off its exposure to the environment via television. Of interest is the fact that Athen's isolation was rendered even more complete in that it was virtually unobserved by other teams. This was due in part to the concentration of most teams upon Bangor and Rutland, the top performers in the first game who formed a coalition in the second.

While not conclusive, an ex post facto consideration of the teams' information-seeking behavior suggests an explanation in terms of the Harvey, Hunt, and Schroder theory. In general, team level of integrative complexity would not seem a sufficient basis for predicting differences in telephone calls on production costs and television usage. A very concrete team, on the one

hand, may be expected to gather concrete facts about the environment due to a compulsive "intolerance of ambiguity," especially if that team is fixated on a detail such as production costs. On the other hand, a highly abstract team may gather the same information, but for purposes of integrating it into more complex schema. Hence both Casper (System I, concrete) and Syracuse (System IV, abstract) were found to obtain production costs and use the television to a great extent. The Athens team, however, is a special case to be explained in terms of system specific properties. As a System II team, Athens would be expected to exhibit "negatively independent behavior," such as to minimize the influence of other teams. Ignoring the television and production costs of specific other teams served this purpose very well. Furthermore, it may be proposed that these tendencies increased over time because the team's frustration in game performance was stressful, leading to a further "shutting out" of the environment.

Information tracking. Knowledge essential to effective bidding is the amount of profits being sought by one's competitors. Extreme deviation in either direction from the norm could have consequences of failure to win contracts or insufficient profits on contracts won. Figure 8 shows the trend of profit margins sought by each of the human teams, compared to the overall norm for human and programmed teams. A team successfully tracking the

norm would show a convergance of the profit margins of successful and unsuccessful bids about that norm, as exhibited by the Bangor, Casper, and Syracuse teams. Considerably more erratic was the profit behavior of Rutland and Athens, although both teams stabilized more in the second game. It may be hypothesized that these two teams experienced difficulty in adjusting to the norms because they made fewer phone calls on production cost information.

Information recording. The considerable freedom permitted the teams in constructing their "contextual maps" allowed the team differences in information processing to be expressed. The maps helped to reveal not only what information the teams regarded as important, but what they did with it. Again, the team composition appeared to be the key determinant, for the more cognitively concrete teams chose to put relatively unprocessed data into the map while the more abstract teams entered more interpretive information.

The dramatic contrast in the content of the contextual map may be illustrated by a few examples. Below are presented samples from Casper, the system I (highly concrete) team, and Bangor, a system III (abstract) team. Casper's entries are primarily of routine data, whereas Bangor has integrated its information for interpretation and strategy analysis.

Casper

Observation of Rutland, 1974

Place - 4th - 98,000
Busy Until - Jan. 31st

Contracts:	Profit	
83 D-B	147,000	1 Fixed fee
86 S-E	129,000	

Remarks: Bid pretty fat, didn't extend themselves too far this time.

Summary - 1974

Did very poorly because of our coalition, decided to drop out. Machines never took a profit over $100,000. Bangor had another big week.

It seems that it is best to take contracts in early part of the year at about $105,000 profit, because late in year, the teams become idle in great numbers and are more cut-throat minded in their bidding.

Bangor

Observation of Rutland, 1974

Rutland developes (sic) low PSS's but does not take full advantage by too high bidding. Their profit margins are very high and if they continue the same policy Rutland will have trouble in the competitive bidding. Rutland's attitude is not one of seriousness. They treat everything quite cheerfully and as competition increases their team may develope (sic) much team conflict, although they are very harmonious now. Rutland is the main competitor of Bangor.

Summary 1974

We do not think that we will be able to make this much profit in the future years if the market retains its competitiveness. We plan to operate on a profit basis considering the degree of competition.

A policy of strategic screwing of a main competitor has proven valuable and may be of use to our overall strategy in the future. We don't plan to bid in either January (ineligible) or February where profit margins will be greatly restricted.

> Our strategy will be based on taking our profits, at the apogee of our PSS effectiveness after the pressure of filling the factory is lessened, therefore lessening competition.

To reveal more precisely the team differences in contextual maps, an exploratory content analysis was made. A coding scheme was devised comprising 30 items, each subsumed under one of the general classes of Present Observations, Future Plans and/or Predictions, and Reconnaissance Assessment (see Appendix). The recording unit comprised a single statement about a team, whether that expressed a concrete bit of information (e.g., Bangor earned $29,000) or a more abstract relationship (e.g., Bangor keeps an extended schedule to avoid being pressed). The context unit[3] was one card in the contextual map.

Analysis was confined to entries on manned teams, to which the participants gave most attention. Some teams did not record observations on team organization, so this category was omitted. The analysis was made on the contextual maps of the first game.

The content analysis proved effective in revealing the differences in information processing among the teams. As this was an exploratory study, different ways of ordering the data were attempted to see what they would reveal. Table 3 compares the teams on some of the dimensions established, which will be explained in the following paragraphs.

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[3]The terms "recording unit" and "context unit" are used in the sense prescribed by Cartwright (1953).

The first line of Table 3 expresses simply the number of units of information recorded for the teams. It is seen that the system III teams had the fewest "bits" of recorded information. This may be due in part to the fact that these teams recorded fewer concrete details, to be discussed below.

Table 3 shows also that the system III teams recorded proportionally fewer observations of other teams compared to their own, suggesting perhaps a greater internally-directed orientation than exhibited by other teams. In contrast, Syracuse, an abstract system IV team showed a very high proportion of externally directed observations. Such openness to the environment is, according to the Harvey, Hunt, and Schroder theory, a characteristic of abstract cognitive functioning. The theory also posits that concrete functioning emphasizes the present over the future, which is given some support by the data (line 3 of Table 3). Moreso than any of the other teams, the observations of the system I team are oriented in the present.

To reveal the nature of the information recorded by the teams, the items in the content analysis were generally categorized as "relatively concrete" or "relatively abstract." The basis for this was a judgment as to whether the item expressed an isolated fact (concrete) or a relationship (abstract). Items placed in each category are as follows:

Concrete:

1. "PSS ability" - the relative "production costs" on word pair solutions;
2. "Profits sought" - the amount of profit sought by teams in their bidding.
3. "Extent of schedule" - the number of months for which a team's factory is filled.
4. "Took fixed fee" - whether or not a team obtained a fixed fee contract.
5. "Bidding frequency" - how often a team bids, the number of contracts it bid on.
6. "Bidding, time of year" - whether a team bid in a certain month, early in game year, etc.
7. "Routine data" - facts routinely provided, such as yearly earnings, relative standing, etc.

Abstract:

1. "General strategy analysis" - statement as to the overall strategy a team is using, the way it is playing the game.
2. "PSS Method" - how another team handles the problem of solving the word pairs.
3. "PSS exploitation" - observation of whether a team uses a low production cost to obtain several contracts on a single word-pair.

4. "Scheduling effects" - the effect that advance scheduling (or lack of) has upon a team's tactics and /or efficiency.
5. "Fixed fee tactical effects" - the purpose that a team has in obtaining a fixed fee contract.
6. "Bidding relative to size of contract" - whether a team alters the amount of its bid according to the number of units in a contract.
7. "Deceptive strategies" - whether a team is deliberately providing false cues to mislead or confuse other teams.

On this basis, all the observations (as opposed to predictions) recorded by the teams were analyzed. As shown in the fourth line of Table 3, the more abstract teams tended to use proportionally more abstract categories. This relationship becomes more distinct by selecting what may be regarded as the two extreme categories -- "routine data" being the extremely concrete category, and "general strategy analysis" as the most abstract category. The use of these categories, shown in the last two lines of Table 3, again indicates a rather strong relationship to the abstractness level of the teams.

It is also of some interest to note that the item recorded most frequently was "profit sought." This was the category used most by three of the five teams, and second in frequency by the

other two.

Discussion

The Game

This first run of the Research and Development Game was shown to have certain limitations as a research method and perhaps as a teaching method. These were as follows:

1. Restriction on the potential for competition. The fact that the overall relative position of the teams changed little within each run of the game indicates that (a) the motivation of the players is likely to diminish and (b) there is little capacity for learning to be reflected in overall standing.
2. Overdependence on ability to solve word pairs. While this factor was not directly correlated with team performance, it was found to be highly relevant to the success of the best performing team in each session. Such dependence on one aspect of the game makes it difficult for a team to exploit other abilities for successful performance.
3. Limited strategies possible. While there were obvious differences in team behavior, the range of variation was limited by the nature of the game. Comments made on the contextual maps and in the de-briefing sessions revealed

that teams often had no well-formulated strategy. The findings that performance was associated mainly with ability to solve a word pairs and obtaining fixed fee contracts, as well as the teams' overwhelming attention to the profits sought, indicate the restricted possibilities.

The Open World

While the use of the closed-circuit television was intended to allow the teams to benefit by observing each other, this advantage was considerably reduced by the general adherence to secrecy and deceptive strategies. These deceptive strategies inhibit research also, for observation of team behavior becomes more difficult. A method is needed in which the teams will regard openness to be more to their advantage. A possible solution is to record the teams' behavior on TV tape, which the players may observe after each game session.

Contextual Maps

The exploratory analysis revealed that the contextual maps were of considerable value in revealing the information processing mechanisms of the teams. Refinement of the analytic method may show them to be even more valuable for this purpose. Suggested possibilities are as follows:

1. The content analysis could be arranged to record the

degree of relationships that the players established among bits of information. That is, levels could be established, the lowest being each detail recorded on the maps. The links established between these elements could then be determined for various higher levels of conceptualization. This would provide a refined measure of the level of abstractness attained by the players in relating to their environment.

2. A simple rating system might prove valuable, if the judges are trained in criteria used to assess the overall content of each card in the contextual map. Such ratings would provide a Gestalt assessment of the maps.
3. A comparison of concepts used over time would provide a means of studying phases in group problem solving. The categories which come to dominate a team's entries would reveal which concepts it considers most salient. This is a means to determine criterion "tracking" by a team, a process referred to by Kennedy, Durkin and Kling (1960) and examined empirically by Tuckman (1963). Indications from both the contextual maps and Fig. 8 indicate that "profits sought" was a criterion tracked by the teams in this game. It might be hypothesized that more abstract teams would reveal a gradual elimination of irrelevant information, while concrete teams

would retain a more constant level of information recording.

One of the main purposes for providing the teams with contextual maps was to give them the possible advantage of exploiting a team "memory" to improve their performance. It was difficult to determine whether the teams actually used the maps for this purpose, or whether in fact the contextual maps improved performance in any way. The maps themselves did not reveal any reference to earlier entries. It may be hypothesized that the map-making process helps to consolidate strategies and integrate team observations, but control groups would be necessary to test this.

The contextual maps were also introduced as a means of recording data on the teams' behavior. While the maps did reveal the ways in which teams processed information, the fact that teams varied in the phenomena recorded indicates that the maps cannot be depended upon to record observations on all categories in which the researcher is interested. The maps should be regarded as supplementary to, but not replacement of, other means of objective data recording. The latter could also be used to assess the veracity of the players' observations.

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Table 1

Personality Composition of Teams

Team Name	System
Casper	1
Athens	2
Bangor	3
Syracuse	4
Rutland	Mixed (predominantly System 3)

Table 2

Relative Standings of Teams in Each Game Year

	Game year	1st Game												2nd Game											
		1971		1972		1973		1974		1975		1976		1977		1978		1979		1980		1981		1982	
	Team	Y	A	Y	A	Y	A	Y	A	Y	A	Y	A	Y	A	Y	A	Y	A	Y	A	Y	A	Y	A
Human Teams	Athens	9		(3)	5	(7)	5	(7)	8	(4)	6	(1)	4	6		(6)	9	(1)	2	(9)	2	(1)	1	(10)	5
	Bangor	1		(1)	1	(10)	1	(1)	1	(3)	1	(4)	1	10		(1)	5	(10)	8	(5)	8	(3)	4	(2)	2
	Casper	4		(4)	2	(5)	3	(10)	5	(2)	3	(6)	5	1		(8)	1	(3)	1	(3)	1	(5)	3	(8)	1
	Rutland	2		(9)	4	(2)	2	(4)	2	(1)	2	(7)	2	3		(7)	6	(4)	5	(7)	5	(4)	5	(2)	3
	Syracuse	8		(5)	6	(6)	5	(2)	4	(5)	4	(2)	3	5		(3)	3	(5)	3	(6)	3	(2)	2	(9)	4
Programmed Teams	Georgia	3		(10)	7	(8)	9	(6)	7	(9)	7	(5)	7	4		(4)	4	(6)	6	(10)	9	(7)	8	(5)	7
	Maine	10		(7)	10	(1)	10	(8)	10	(6)	9	(3)	8	9		(9)	10	(8)	10	(2)	10	(10)	10	(1)	10
	Wyoming	7		(6)	8	(4)	7	(5)	6	(10)	10	(8)	9	6		(2)	2	(8)	7	(4)	4	(6)	6	(4)	6
	Vermont	5		(2)	3	(9)	4	(3)	3	(7)	5	(9)	6	8		(5)	8	(7)	9	(1)	6	(8)	7	(7)	8
	New York	6		(8)	9	(3)	8	(8)	9	(8)	8	(10)	10	2		(9)	7	(2)	3	(8)	7	(9)	9	(6)	9

Y = year's standing

A = accumulated earnings standing

Table 3

Results of Contextual Map Analysis

	Team (system type in parentheses)				
	Casper (I)	Athens (II)	Bangor (III)	Rutland (III)	Syracuse (IV)
Total bits of information	111	185	84	34	128
No. observations on others ÷ no. observations on own team	3.82	3.02	2.50	2.40	8.10
Present observations + future predictions	26.75	2.49	2.36	16.00	2.45
% abstract observations	5.6%	28.8%	40.7%	37.5%	31.6%
"General strategy analysis" - N	0	0	6	6	4
"Routine data" - N	29	16	7	2	6

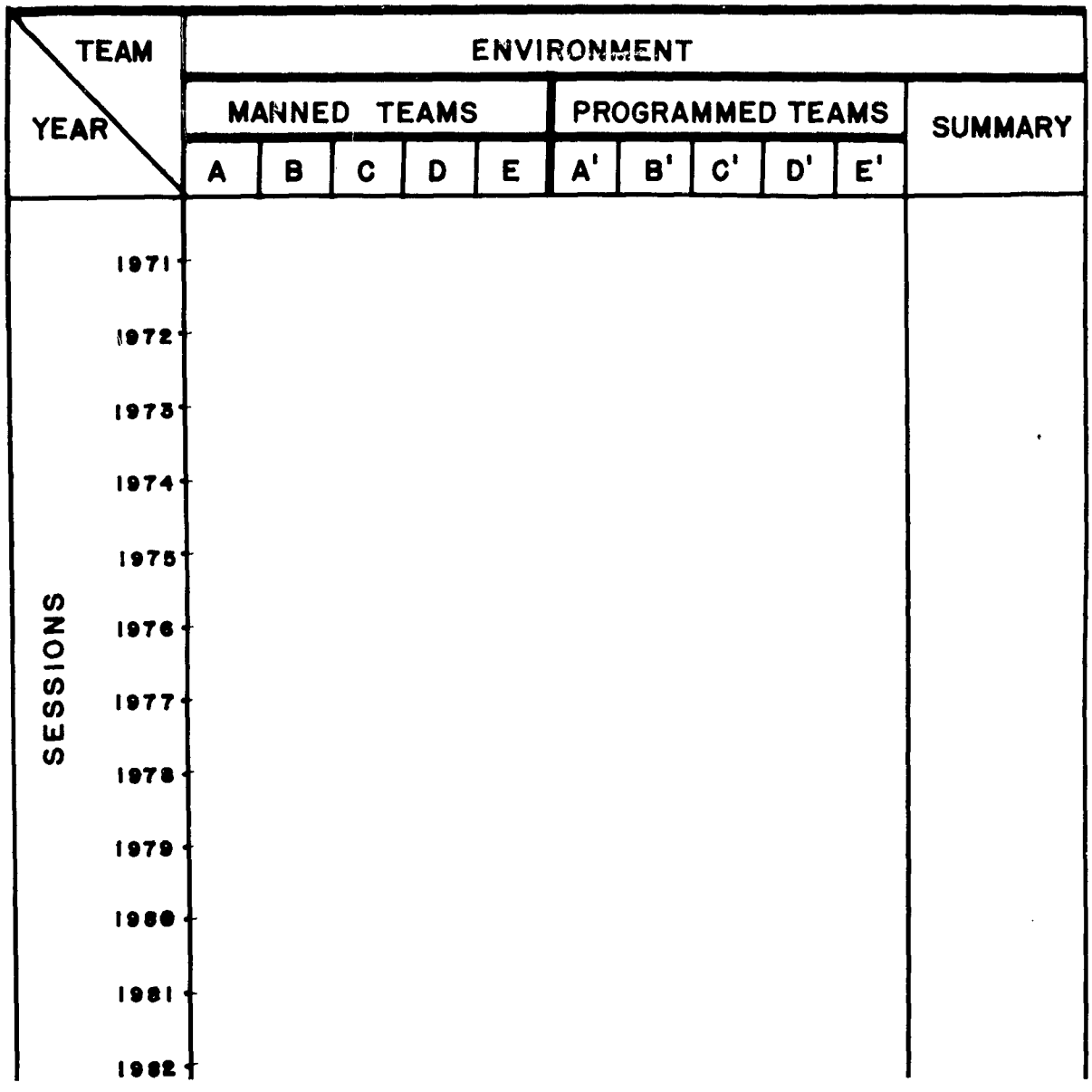


FIGURE I. CONTEXTUAL MAP MATRIX

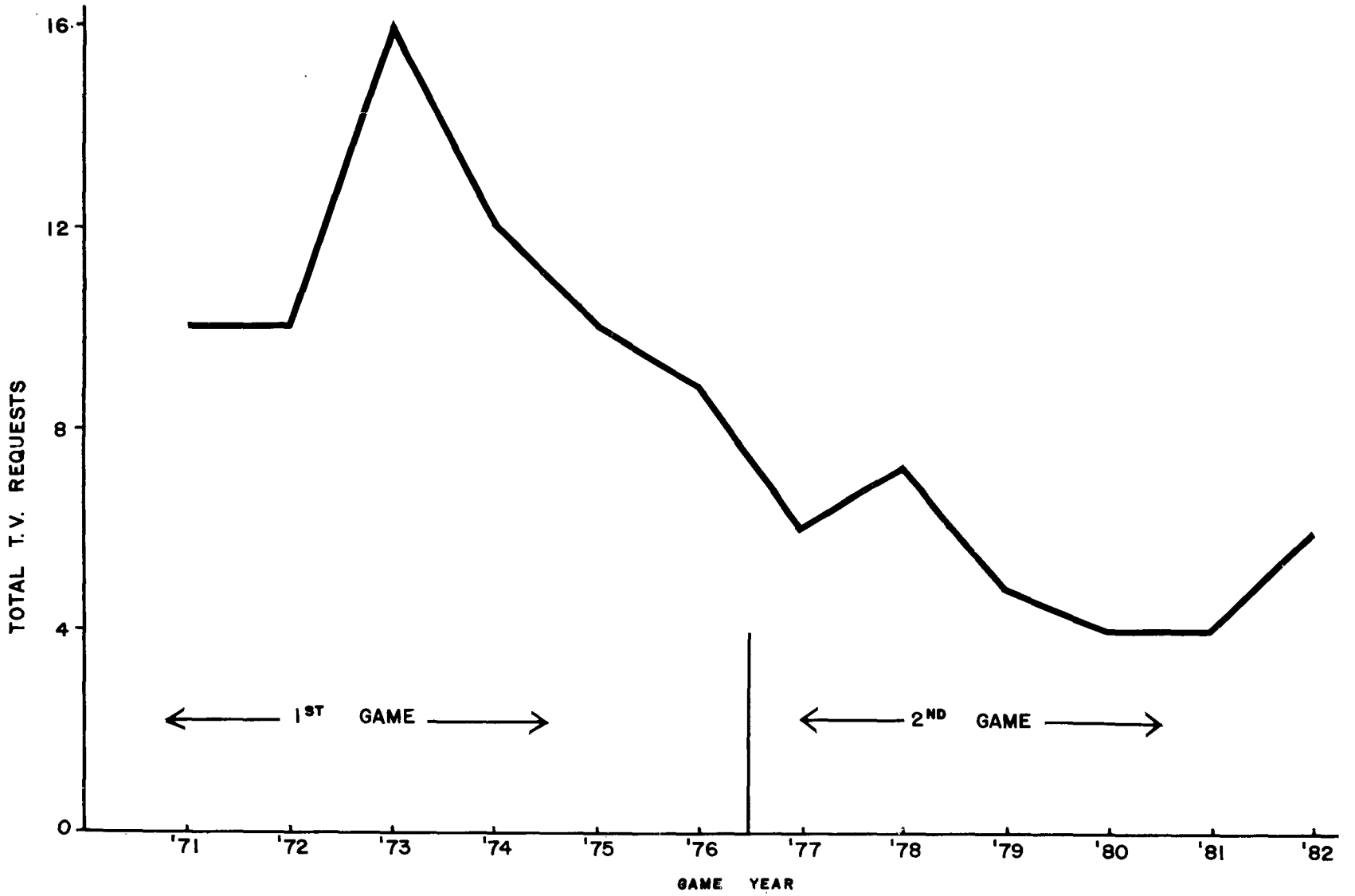


FIGURE 2. TELEVISION ACTIVITY OVER TIME.

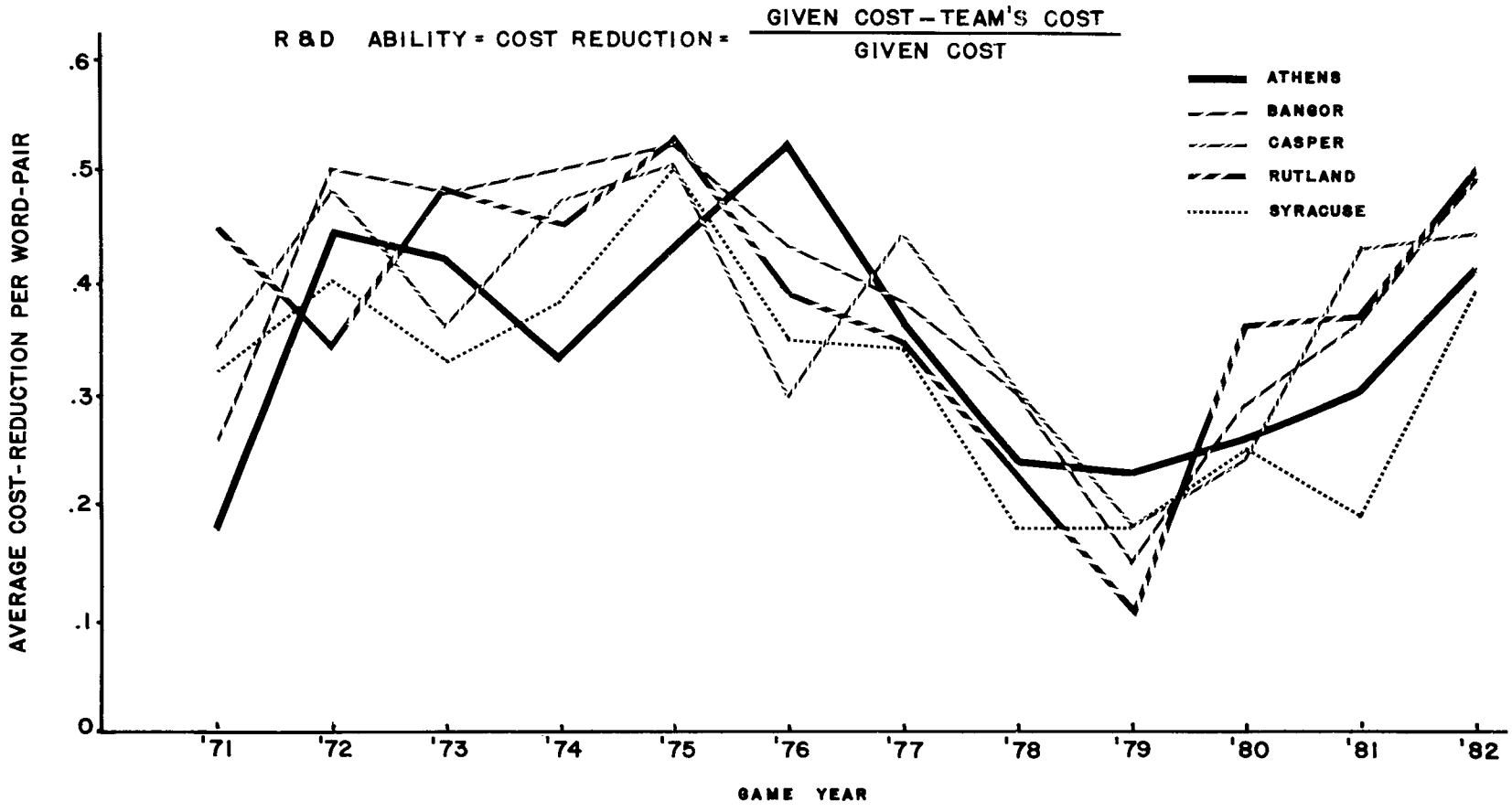
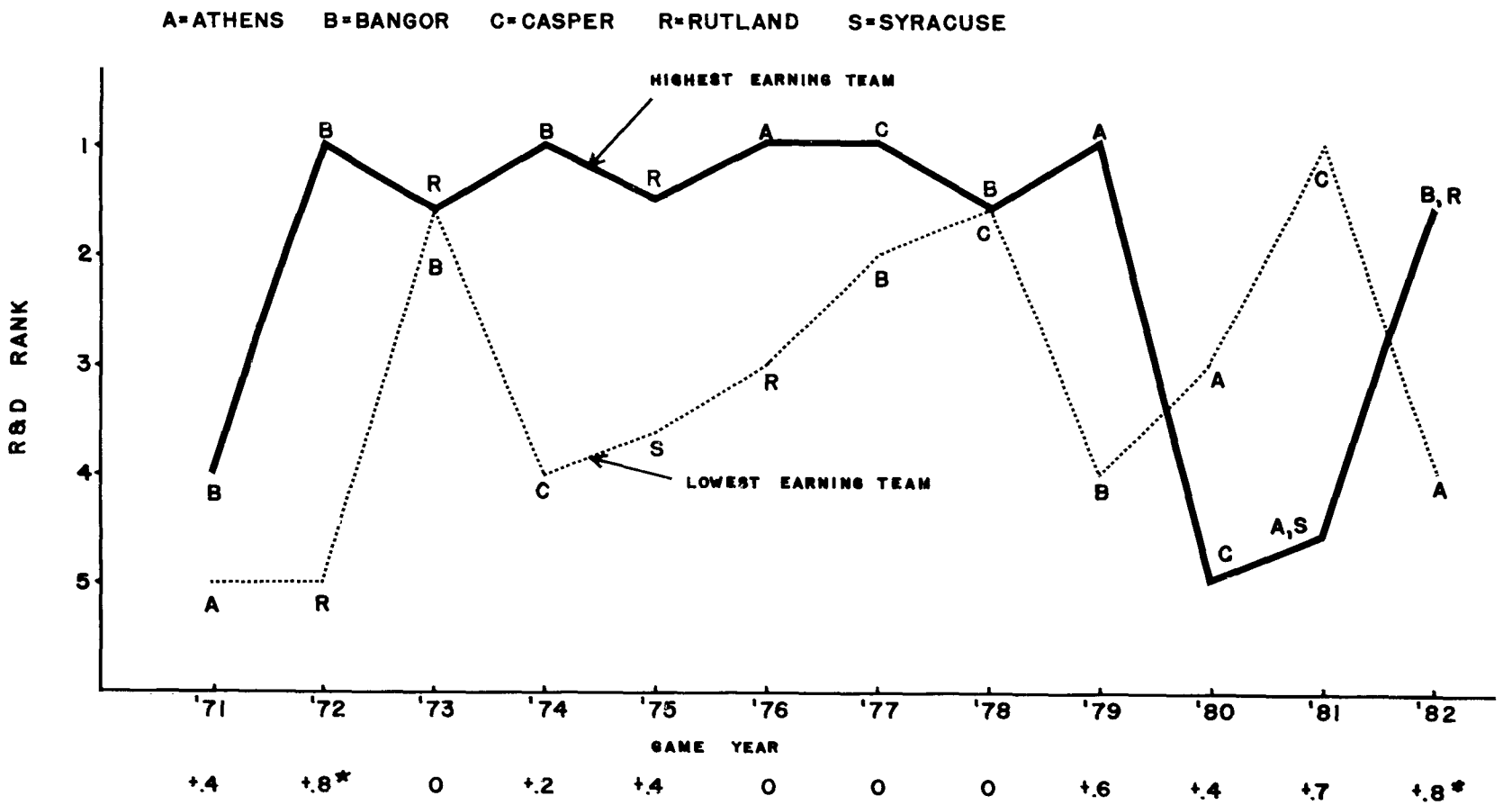


FIGURE 3. R&D ABILITY OVER TIME.



OVERALL CORRELATION BETWEEN R&D ABILITY AND EARNINGS RANK - KENDALL τ

* = SIGNIF. @ .05

FIGURE 4. RELATIONSHIPS BETWEEN R&D ABILITY AND FINANCIAL PERFORMANCE.

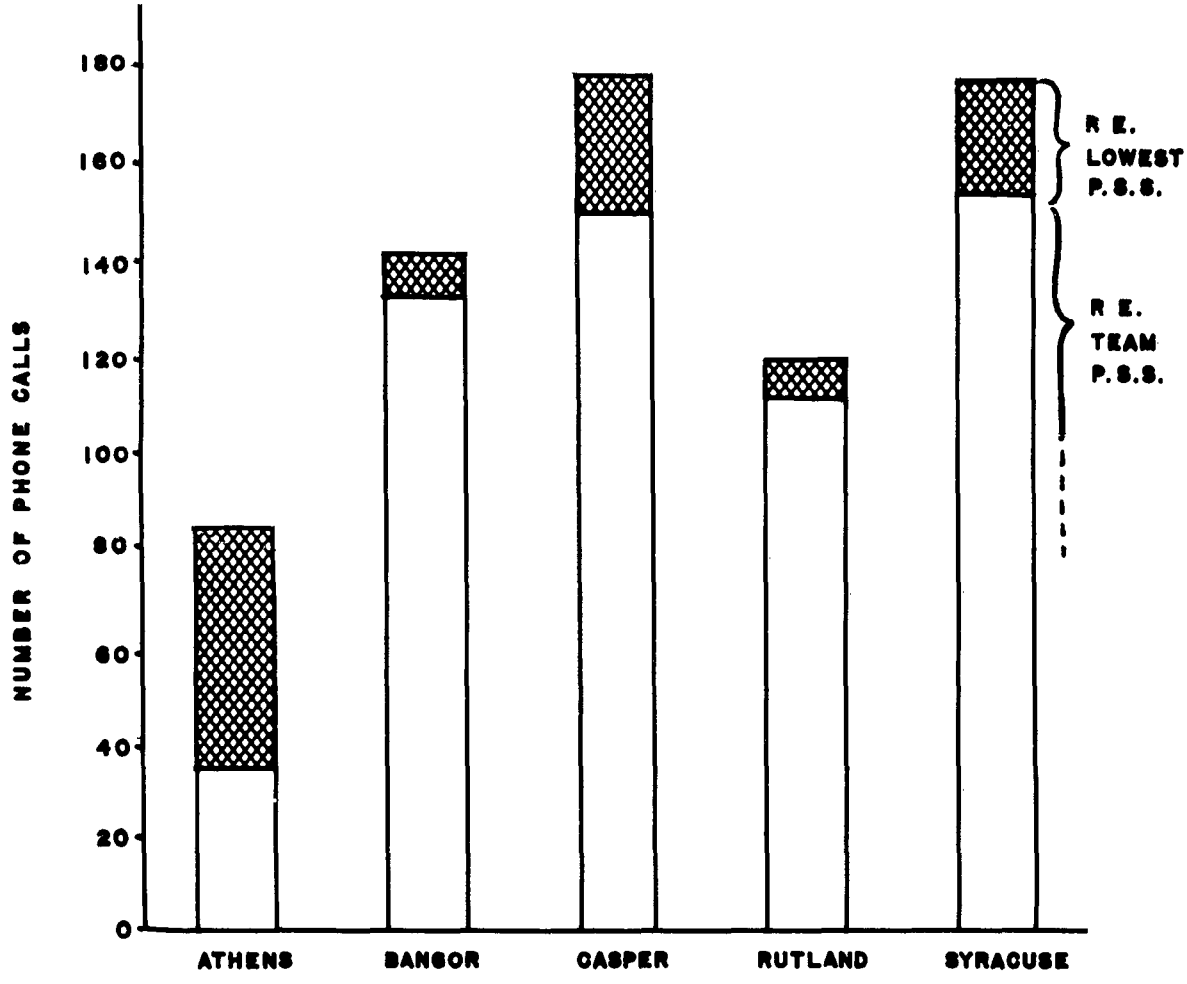


FIGURE 5. PRODUCTION COST INFORMATION SEEKING

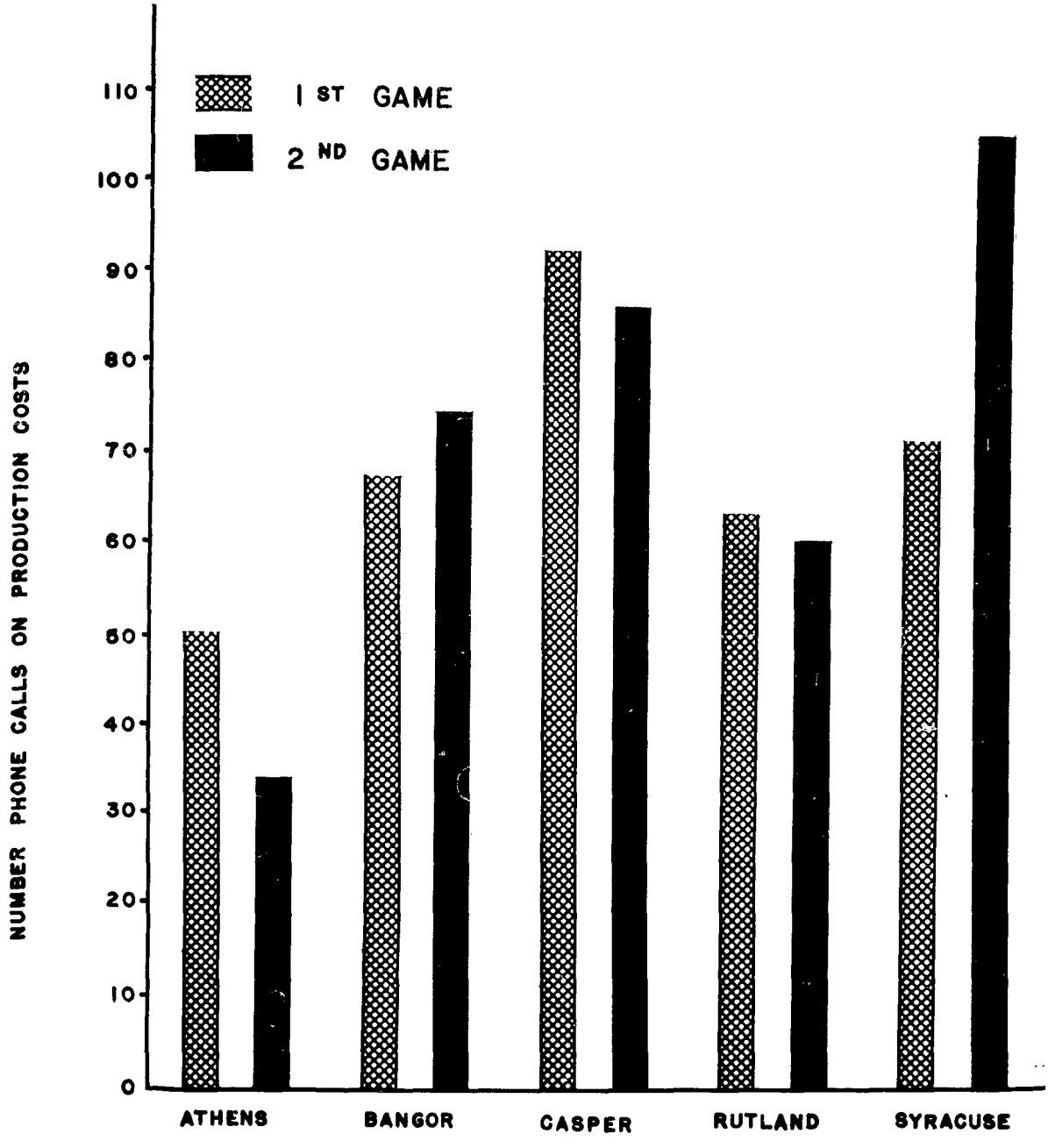
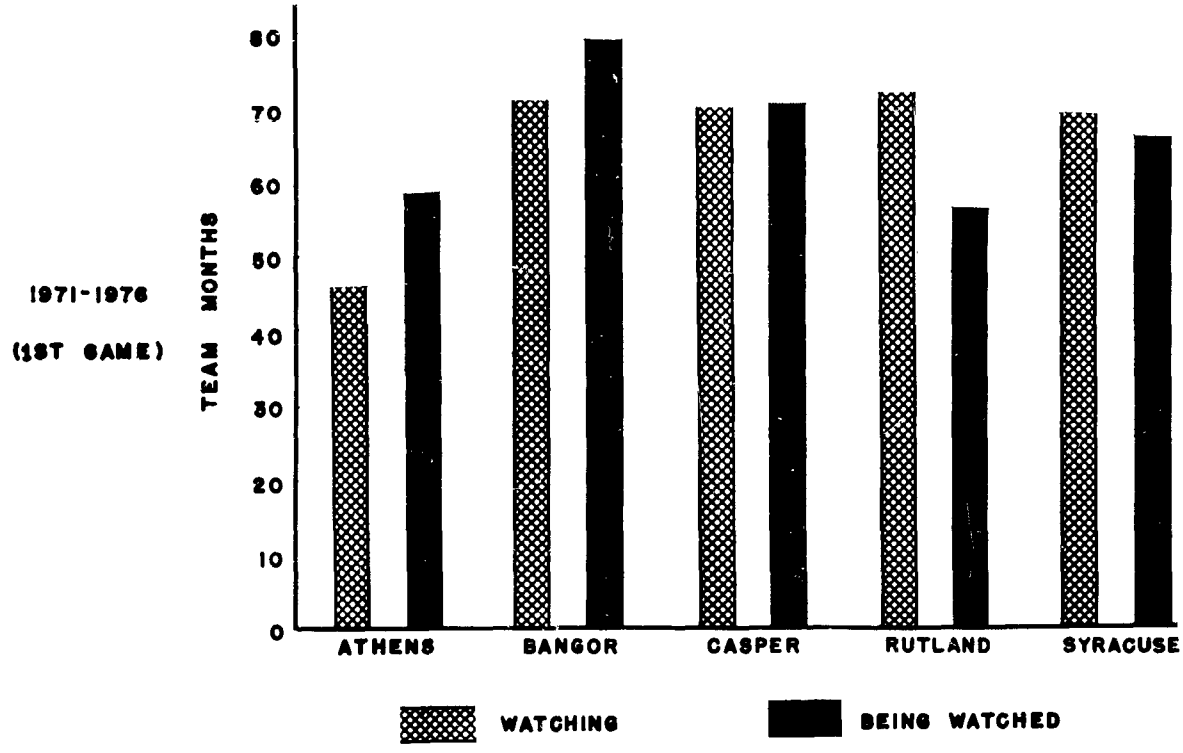


FIGURE 6. PRODUCTION COST INFORMATION-SEEKING OVER TIME.



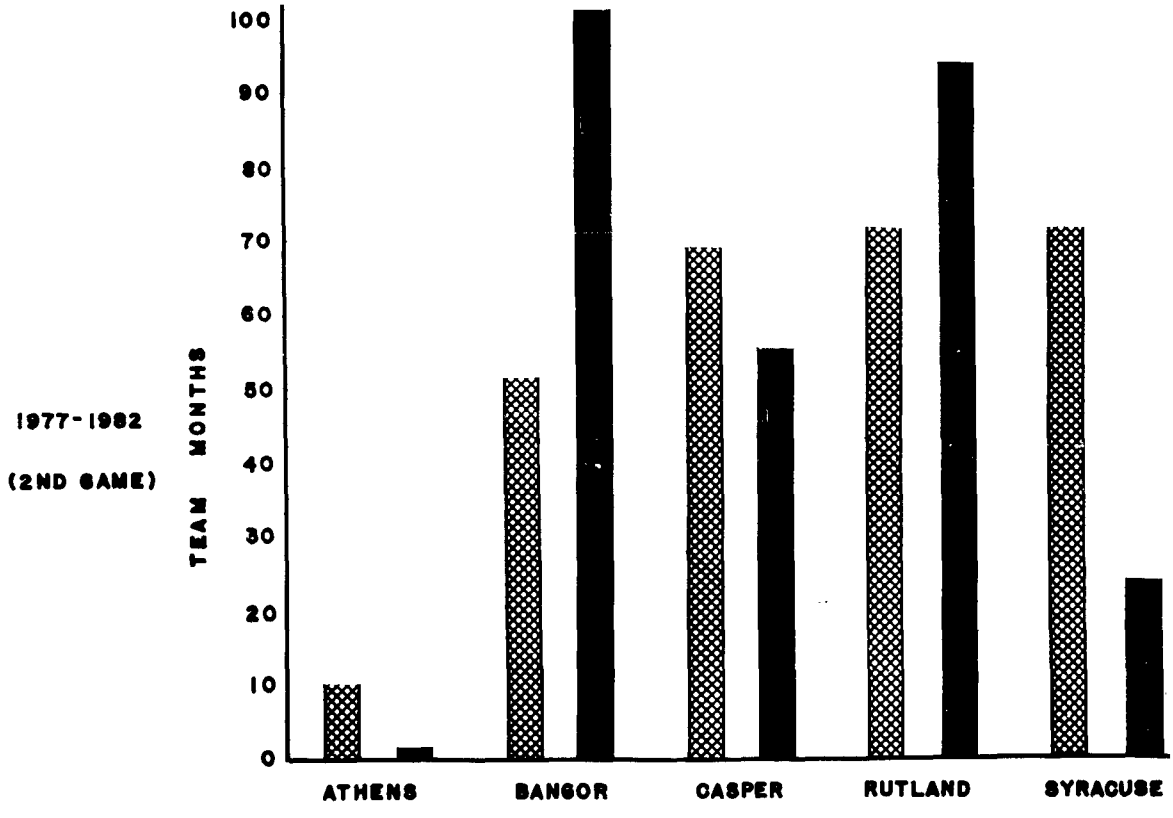


FIGURE 7. TELEVISION USAGE

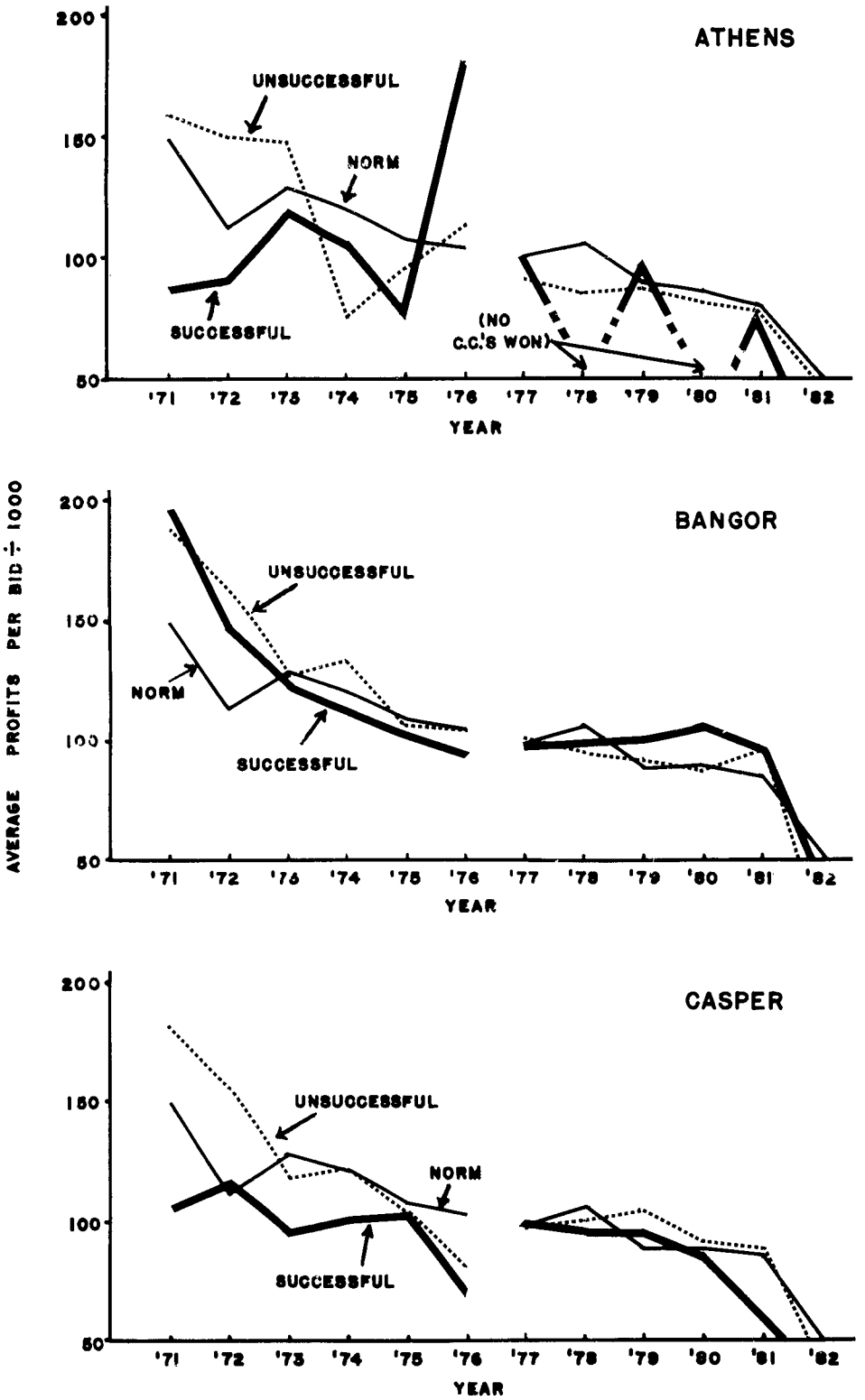


FIGURE 8. PROFIT SEEKING OVER TIME (NORM INCLUDES PROGRAMMED TEAMS).

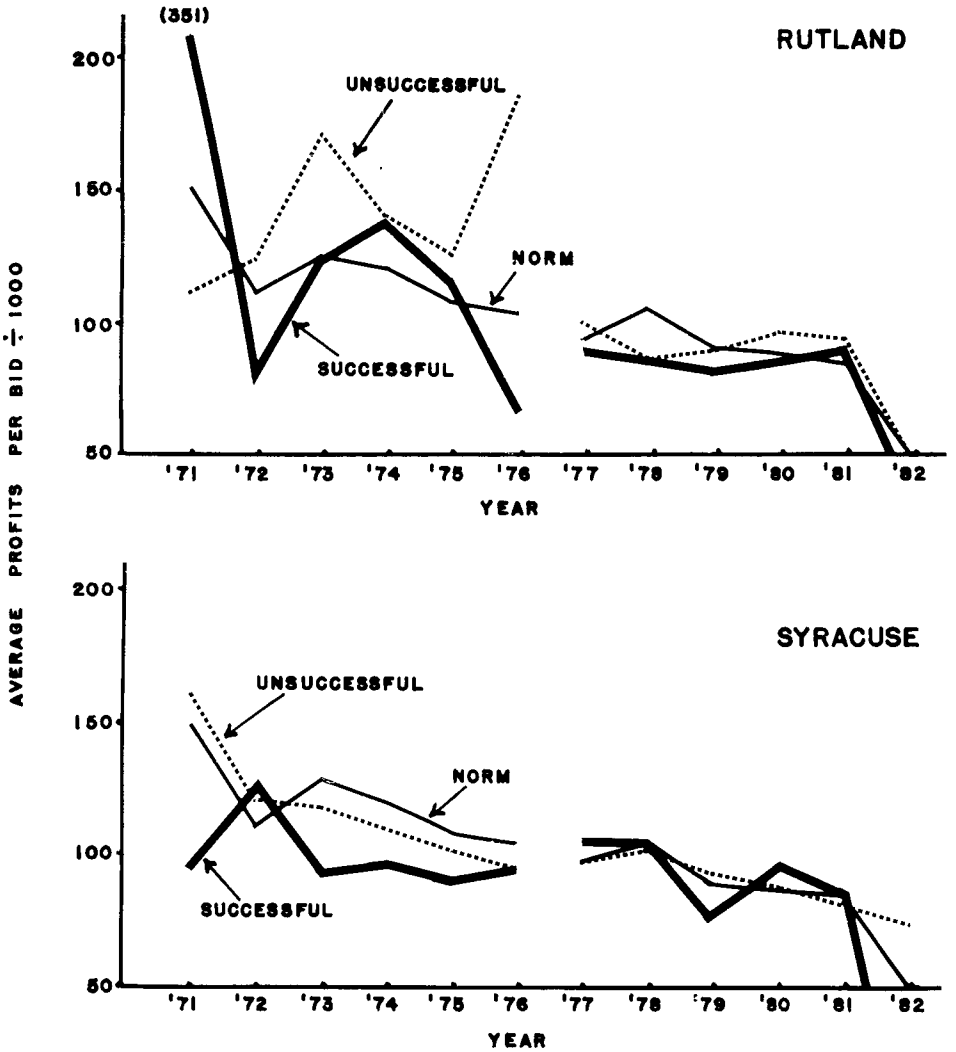


FIGURE 8. (CONT.) PROFIT SEEKING OVER TIME (NORM INCLUDES PROGRAMMED TEAMS).

APPENDIX A

PLAYERS' MANUAL

Research and Development Game

September, 1962

OBJECT

This is a manufacturing game, in which your team will be developing production processes for certain products and then bidding for contracts to manufacture and sell these products. You should try to maximize your own profits while competing with other teams in two areas:

1) Research and Development - the game has been designed so as to simulate the process of inventing and developing new and better ways to produce specific products. Your team will find it necessary both to do research and development and to make decisions about how much and what kind of research to do.

2) Management and Policy Making - you will need to interpret market conditions, project a production schedule, and decide when and how much to bid for contracts.

It is up to you and your teammates to decide how to divide your time and how to organize yourself to do these tasks most effectively. Your object is to make money, and the right approach for your team is the one that works the best. Your financial standing in the game will be based on your profits from the contracts you have won by successful bidding.

THE PRODUCTS

Each product in this game consists of a 5-letter word, manufactured out of another 5-letter word by means of a word-chain. Each link in the chain represents a manufacturing process. There are 3 processes by which the finished product may be manufactured. The first, and the least expensive, requires that only one letter be changed at a time and the 4 letters remain unchanged and in the same position. If it becomes desirable, the second, and more expensive process may be used which permits the 5-letter word to be scrambled, i.e., the letters may be rearranged. If it is necessary, the third process, combining the first two operations may be used; the letters may be scrambled and one of the letters changed. This is the most expensive of the three manufacturing processes.

The schedule of production costs per step in the production process will be:

$0.10 per word with one letter changed (unscrambled)
0.20 per scrambled word (no letter changed)
0.50 per scrambled word and one letter changed

All 5-letter words used in the word-chain must be legitimate English words, i.e., words listed in Webster's New Collegiate Dictionary. Verb forms and commonly used plurals are acceptable. The following is a list of some unacceptable word forms:

1) Proper nouns or names
2) Foreign words not listed in Webster's Dictionary
3) Slang words not listed in Webster's Dictionary
4) Contractions
5) Abbreviations

The following example, connecting JUDGE to FINAL, will illustrate a complete word-chain in which all three manufacturing processes have been used.

JUDGE	.10
BUDGE	.10
BULGE	.10
BUGLE	.20
GABLE	.50
FABLE	.10
FALSE	.50
FLEAS	.20
FAILS	.50
FINAL	.50

Thus, the Total Cost of producing each unit of JUDGE-FINAL would be $2.80. Suppose your team decides to bid on an amount 50% higher than your cost. Your bid would be $4.20 per unit. The Total Cost ($2.80) includes raw materials, shipping costs, etc. Superior production methods would reduce this cost.

Before you commit yourself to a word-chain, it will be possible for you to check on the acceptability of any word you may wish to use by telephoning the operator. She will record your word and refer it to the judges. As soon as possible, after you phone in your question the Mailman will deliver the judges' decision. Their decision will be final.

TIME COMPRESSION

Each three-hour laboratory session will represent one year. (See the section on Sequence of Events.) The switchboard will be open for calls during the last five minutes of each month.

PRODUCT SPECIFICATIONS

At the beginning of each game year each team will receive an identical "ANNUAL CONTRACTS LIST" of products (word-pairs) for which contracts will be awarded during the next twelve months. This list represents the possible products your team may manufacture if it is successful in winning a bid. Each team will be given an identical "PRODUCT SPECIFICATION SHEET" for each word-pair, listing one possible word-chain and its cost of production. Your team may elect to bid on a contract for this product based on this cost or you may choose, by your own research, to develop your own manufacturing process and invent your own word-chain at less cost than the one given you and then bid on a contract for this product based on your own cost. (See section on Contracts.) The products of different teams are assumed to be of equal quality and different only in the cost of production.

Should you choose to develop your own process, enter your word-chain for that product as well as the cost on a blank PSS (Product Specification Sheet). When it is fully prepared, place it in the out-going mailbox and it will be picked up at the end of the first five minutes of each month. The judges will review it to make sure that acceptable words have been used and that the cost of production is calculated accurately. The Intercom will announce one minute before the switchboard opens each month whether your team's PSS has been approved or not. Once a PSS has been approved, the new cost may be used for bidding during the same or any succeeding month of that year. The judges' decision will be final. PSS's which are Unapproved will be returned to the team, but those which are Approved will be kept by the judges. It will be useful for you to make a duplicate copy of your PSS for your own records with carbon paper provided.

Should you wish information on your competitors' production costs, you may telephone the operator and ask for one of two pieces of information:

1) the production cost of a given product submitted by a particular team or
2) The lowest production cost submitted thus far for a given product.

Each month two competitive contracts, providing for the manufacture and sale of a given number of units of a particular product, come up for bidding.

CONTRACTS

Each product (word-pair), such as JUDGE-FINAL, in the example given above, is associated with a Contract Number. A new set of four word-pairs will be used for the 24 contracts in a 12-month period (Mar. - Feb.). All PSS's applicable to January and February contracts must be submitted the preceding year. All four of the word-pairs used from March to December will be the basis for contracts during January and February of the following year. Each time a word-pair comes up again it is not necessary to submit a new PSS unless you have discovered a new and cheaper word-chain. Profits will be calculated on the basis of the original cost given to you for the product or, if you submitted your own word-chain, on the last PSS Approved before the bid on the Contract was received.

The team may bid on the Contract by phoning the operator. Give the name of your team and state your bid in dollars per unit. Wait for the operator to repeat your bid, before hanging up, and indicate that it has been correctly received. On the last day of the month the Contract will be awarded to the team submitting the lowest bid. In the case of ties on bids the first bid received by the operator will be given priority.

In addition to the competitive Contracts which are open for bidding, a limited number of Fixed-Fee Contracts are also available. Fixed-Fee Contracts provide some work and a small margin of profit for teams so that the team may keep its employees occupied and earn some income during periods when they are not working on competitive Contracts, where the large profits potentially exist. The awarding of Fixed-Fee Contracts will be announced over the Intercom. If they have not been granted, no announcement will be made. (See section on Eligibility.) The Fixed-Fee contracts and the income from each will be made available at the beginning of each year.

FACTORY SCHEDULING

Each team will be regarded as having limited factory facilities, sufficient to permit production on only one Contract at a time. Three months of factory time must be allowed for production and delivery on a competitive Contract and four months of factory time for production and delivery on a Fixed-Fee Contract. Each

team should keep track of its current "delivery date," i.e., the last day of the last month it has filled on its factory schedule. Scheduling on a new Contract begins on the first day of the month following the Contract award or following the team's existing delivery date, whichever comes later. In order to be awarded a contract, a team must guarantee delivery within nine months from the day the contract is awarded.

Example I. At the beginning of the game, all teams start with a pre-existing delivery date of April 30, 1971. A team which is awarded a Competitive Contract in January adds three months to its delivery date, changing it to July 30, 1971. This team may still bid on a Competitive Contract in February because it can deliver on October 30, 1971, only 8 months after the February 28, 1971 contract award date. If it obtains this contract also, it would not be eligible to bid in March because the delivery date would be January 31, 1972, 10 months away.

Example II. Another team, failing to get a competitive Contract in January, February or March, 1971, would need to decide in April what to do about keeping its factory fully scheduled for May. This team could either:

a) stay in the bidding for April at the risk of having an idle factory in May if it fails to win the bidding, or

b) obtain a Fixed-Fee Contract in April, if available, to keep its factory operating in May, or

c) obtain a Fixed-Fee Contract in April, if available, and also bid on one of the two Competitive Contracts offered in April.

Your team should keep careful records of the Contracts you hold and the dates on which they begin and expire so that you do not bid on or apply for more Contracts than you are permitted to hold. If a team requests a Contract when it is, in fact, ineligible to have one, it will not be awarded to that team even though it may have submitted the lowest bid.

A team may request information on the eligibility of its competitors to bid on Contracts. In any one call, the team may request either:

a) the number of teams eligible to bid on the current contract, or

b) the latest delivery month for any specific team.

Teams do not have to bid on Contracts unless they wish to do so. At all times they may be working on developing new and cheaper processes for any number of products even though Contracts for these products will not come up for bidding until later in the year or until January and February of the following year.

Profit from Contracts is credited to the team account as of the month the Contract is awarded. On competitive Contracts, the production cost per unit is the lowest cost the team has had approved before submitting its bid. Thus a PSS approved in October does not reduce the team's cost on a September Contract, nor on any earlier Contract which the team may still have waiting for or in production.

SWITCHBOARD

During all months, the switchboard is open during the last 5 minutes. Each team will probably be able to get at least two calls through to the operator each month, depending on demand. Only one request is to be made during each phone call. There will be a $1000 fee for each phone call made. When the operator answers your call she will say "Firm please." Identify yourself with team name and state your request. The operator will repeat it to you so that you may be sure it is understood correctly and she will wait for you to confirm what she has said to indicate any changes you wish to make. Failure to confirm your request will mean it will not be honored. You will be charged for every phone call whether or not you have confirmed your request.

The telephone is to be used only for the following purposes:

1) to bid on one of the current Contracts

2) to request a Fixed-Fee Contract

3) to check a word

4) to request cost information

5) to request eligibility or delivery date information

6) to request TV and sound for a particular team (Athens, Bangor, Casper, Rutland, Syracuse).

The operator is not authorized to handle any other matters over the telephone.

FINANCIAL STATEMENTS

At the beginning of each year, you will receive a Financial Statement, showing your Net Earnings for the preceding year. Net Earnings are based on the profits from any Contract awarded during the year. There is a fixed overhead charge of $250,000 per year as well as $1000 charge for each phone call made during the year. The sample Financial Statement will illustrate the elements contributing to your net earnings.

At the beginning of each year, each team will receive a Comparative Standings Form showing the Net Earnings of all teams for the previous year and the Net Accumulated Earnings of each team to date.

TIME

1:20 START OF JANUARY - Financial Statements delivered in mailbox

- Annual Contracts List delivered in mailbox

1:24 - Intercom announcement of approved PSS's

1.25 - Intercom: Bidding on contracts #N and N+1 for Jan. now open - switchboard opens

- Intercom announcement of Fixed-Fee Contract awards
- Intercom announcement of Competitive Contract awards

1:30 START OF FEBRUARY

1:39 - Intercom announcement of approved PSS's

1:40 - Intercom: Bidding on Contracts #N and N+1 for Feb. now open - Switchboard opens

1:44 - Intercom announcement of Fixed-Fee Contract awards
- Intercom announcement of Competitive Contract awards

1:45 START OF MARCH (same event sequence as February)

2:00 START OF APRIL (same event sequence as February)

2:15 START OF MAY (same event sequence as February)

2:30 START OF JUNE (same event sequence as February)

2:45 START OF JULY (same event sequence as February)

3:00 START OF AUGUST (same event sequence as February)

3:15 START OF SEPTEMBER (same event sequence as February)

3:30 START OF OCTOBER (same event sequence as February)

3:45 START OF NOVEMBER (same event sequence as February)

4:00 START OF DECEMBER (same event sequence as february)

4:05 - Intercom: Bidding on Contracts N N+1 for December is now open

4:09 - Intercom announcement of Fixed-Fee Contract awards

- Intercom announcement of Competitive Contract awards

4:10 END OF YEAR

WHEN THE SWITCHBOARD IS OPEN, TEAMS MAY PHONE THE OPERATOR TO:

1) Bid on a contract

2) Request a Fixed-Fee Contract

3) Request check of a word

4) Request cost information

5) Request eligibility or delivery date information

6) Request for TV and sound of one of the following teams:

ATHENS
BANGOR
CASPER
RUTLAND
SYRACUSE

CALLS WILL BE CHARGED TO YOUR ACCOUNT AT $1000/call.

PRODUCT SPECIFICATION SHEET

MONTH SUBMITTED FEB. PRODUCT JUDGE-FINAL WORD-PAIR TEAM X

MONTH APPROVED _____ YEAR 1972

MONTH UNAPPROVED _____

		*			*
1	JUDGE	.10	21		
2	BUDGE	.10	22		
3	BULGE	.10	23		
4	BUGLE	.20	24		
5	GABLE	.30	25		
6	FABLE	.10	26		
7	FALSE	.50	27		
8	FLEAS	.20	28		
9	FAILS	.50	29		
10	FINAL	.50	30		
11			31		
12			32		
13			33		
14			34		
15			35		
16			36		
17			37		
18			38		
19			39		
20			40		

TOTAL COST = $2.80 per unit

* Enter $0.10, $0.20, or $0.50

FINANCIAL STATEMENT

TEAM X

YEAR 1972

CONTRACT NUMBER	MONTH AWARDED	PRODUCT WORD-PAIR	COST	BID	# UNITS	(BID-COST) x # UNITS) PROFIT
1	Jan.	Judge-Final	2.80	4.20	100,000	140,000
103	July	Fixed-Fee				100,000
18	Sept.	Organ-Music	2.90	4.35	100,000	145,000

PHONE CALLS

MONTH	CALLS
Jan.	1
Feb.	3
Mar.	4
April	3
May	2
June	3
July	3
Aug.	4
Sept.	3
Oct.	2
Nov.	3
Dec.	1

TOTAL 32

NEW PROFITS 385,000 (A)

OVERHEAD CHARGES:

FIXED OVERHEAD 250,000 (1)

32 CALLS @ $1000 each 32,000 (2)

TOTAL OVERHEAD 282,000 (B)
(1 + 2)

NET EARNINGS 103,000
(A - B)

APPENDIX B

Scoring Categories for Content Analysis of Contextual Map

A. Present observations
   1. General strategy analysis
   2. PSS method
   3. PSS ability
   4. PSS exploitation
   5. Profits sought
   6. Extent of schedule
   7. Scheduling effects
   8. Took Fixed Fee contract
   9. Fixed Fee tactical effects
   10. Bidding relative to size of contract
   11 Bidding frequency
   12. Bidding, time of year
   13. Routine data
   14. Deceptive strategies

B. Future plans and/or predictions
   1. PSS method
   2. PSS ability
   3. Profits to be sought
   4. Schedule to be sought
   5. Predicted effects of schedule
   6. Use of Fixed Fee contracts
   7. Fixed Fee tactical effects
   8. Bidding relative to size of contract
   9. Bidding frequency
   10. Bidding, time of year
   11. Relative performance expected
   12. Counteractive strategies necessary

C. Reconnaissance assessment
   1. Tactical value of television
   2. Strategic value of television
   3. General evaluation of television
   4. Value of PSS information